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# EXTERNAL ROTOR GAS TURBINE
App. No: 10/090,260

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## References Cited ~~[Referenced By]~~

U. S. Patent Documents

| | | |
|---|---|---|
| 2,592,938 | Apr., 1952 | McNaught |
| 6,347,507 | Feb., 2002 | Lawler |

Primary Examiner: Ehud Gartenberg

## ABSTRACT

An external rotor gas turbine engine with the turbine consisting of a pressure vessel with single stage expansion nozzles located near the periphery tangentially oriented to provide reaction force torque to power the compressor and providing high velocity exhaust gases to, in the preferred embodiment, power an impulse turbine ~~to provide direct high speed thrust or to provide rotational shaft work to power electrical generators or aircraft engine fans~~. ~~To supply~~ An external rotor dynamic compressor supplies the rotating inlet of the turbine or combustor with compressed air. ~~to the rotating inlet of the turbine or combustor, the dynamic compressor has an external rotor journaled onto an internal stator~~. The entire outside of the engine

rotates eliminating seals. ~~allowing for a sealless high pressure rotating air source to the exoskeletal turbine.~~ ~~For the prime mover embodiment, the residual kinetic energy from the rotating nozzles may be recovered by an impulse turbine. For the high speed propulsion engine, the impulse turbine is replaces with stator vanes to redirect the momentum in an axial direction.~~

**18 Claims, 4 Drawing Sheets (attached)**

## CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable

## ~~STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT~~

~~Not applicable~~

## ~~REFERENCE TO SEQUENCE LISTING, A TABLE, OR A COMPUTER PROGRAM LISTING COMPACT DISK APPENDIX~~

~~Not applicable~~

## BACKGROUND ~~FIELD~~ OF THE INVENTION

This invention relates to gas turbine engines, specifically to external rotor/internal stator, single stage expansion reaction turbine ~~jet~~ gas turbine engines.

## ~~BACKGROUND—DESCRIPTION OF PRIOR ART~~

Brayton thermodynamic cycle internal combustion engines can be categorized by the type of machinery used to compress air and expand combustion gases. The common turbo machinery engine typically has ~~will~~ ~~have~~ a highly machined finely bladed internal rotor dynamic compressor ~~to compress air~~ powered by a ~~similar device~~ similarly bladed internal rotor turbine to expand combustion gases. Unlike the centrifugal or axial compressors, however, the blades of the turbine are completely immersed in hot combustion gases. Extraordinary efforts at developing

advanced alloys and sophisticated cooling techniques are necessary to keep the turbine blades operating at reasonably high inlet temperatures and efficiencies. Up to twenty five percent of compressor air is wasted in film cooling of some high performance gas turbine engines. Not only is the engine expensive to design and build, the overall efficiency is reduced by up to ten percent. Moreover, rotor tip clearance leakage losses are significant in an engine that must operate over a range of temperatures including cold start up.

Eliminating the turbine blading ~~bladed internal rotor of~~ in the gas turbine engine was the goal of many inventors for decades.

McNaught (Pat. No. 2,592,938; April, 1952) develops rotational shaft work to power a compressor by expanding combustion gases through nozzles mounted on the periphery of a pressure vessel for a jet reaction turbine. The conventional internal rotor compressor, however, requires a heavy external spinning linkage shell in order to be powered by the turbine. The engine is impractical to fabricate or operate.

More recently Lawler (U.S. Pat. No. 6,347,507; Feb., 2002) mounted ram jets on the tip of a rotor and eliminated, not only the internal rotor of the turbine but the internal rotor of the compressor as well. The philosophy behind what was intended to be the ultimate low tech engine is then promptly contradicted by a high tech rotor which must withstand the enormous rotational stresses due to Mach 2.5 tip speeds. In addition to air friction losses, fuel delivery or exhaust gas problems, the engine has what might be considered contradictory design points ~~in a conventional engine~~. Since both propulsive efficiency and pressure ratio are always a function of the same parameter, tip speed, the engine designer has limited options to maximize overall efficiency.

## ~~BRIEF~~ SUMMARY OF THE INVENTION

The above problems are elegantly eliminated by the external rotor gas turbine, Fig. 4, ~~compressor~~ in pending patent application Ser. No. ~~60/273,426~~ 10/090,260 ~~for an external rotor gas turbine~~. As with the McNaught and Lawler engines the internal rotor bladed turbine is eliminated thereby reducing the surface area contacting ~~of~~ the expanding combustion gases, ~~and, therefore,~~ which reduces the film cooling requirements and increases the Reynolds numbers ~~by an order of magnitude~~. Unlike the McNaught engine, however, the need for complicated rotating ~~structures~~ machinery and seals is eliminated because the external rotor turbine on this engine is attached to, or integral with, an external rotor dynamic compressor. ~~The entire outside casing of the engine spins.~~ Moreover, unlike the Lawlor engine, the dynamic compressor allows the engine designer to select and operate at any compression ratio over a broad range of tip speeds for an optimum design point. ~~The rotational stresses are greatly reduced. at an optimum design point. With a counter rotating impulse turbine, rotational stresses may be reduced by up to an order of magnitude.~~

The high speed aircraft engine embodiment allows for top end speeds of a ram jet yet with ground take off capability.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1: A cross section along the axis of the center of rotation of a prime mover for generating rotational shaft work **18**. Air enters the external rotor axial compressor from the right side of the engine **20**, and, after combustion in the axially mounted combustion chamber **14**, the gases then move radially out to the tip mounted nozzles **2**. The kinetic energy remaining in the exhaust gas jets is recovered by a ~~one~~ single stage counter rotating impulse turbine **8** located in a radial direction from the nozzles and geared **10** to the reaction turbine. The fuel line is placed inside the hollow shaft **16**.

Fig. 2: A cross section of an aircraft engine embodiment.

Fig. 3: A cross section with the combustion taking place near the rim of the jet rotor.

Fig. 4: A cross section of the preferred embodiment, a prime mover with a two stage external rotor centrifugal compressor.

## DESCRIPTION OF THE ~~INVENTION~~ PREFERRED EMBODIMENT

Referring to Fig. 4, the external rotor centrifugal compressor on the right side of the drawing supplies the reaction turbine combustor **112** with a sealless rotating source of compressed air. The reaction turbine nozzles **102** are very similar to ram nozzles and allow for ~~stoichiometric~~ relatively high combustion temperatures with little or no film cooling. The fuel line, controls, pump, starter, combustor, regenerator and other peripherals could simply be routed through ~~or mounted on~~ the center of the compressor on the stator **116** instead of around the outside casing as in a conventional engine.

Preferably, the nozzles in the preferred embodiment are angled ten to 15 degrees in the axial direction so the remaining kinetic energy would power a conventional axial impulse turbine **108** for rotational shaft work **118.**

The design analysis requires only a conventional understanding of the basic principles of fluid mechanics, heat transfer, rotational stresses, and other turbo machinery fields. Except for the throats of the nozzles which may require some film cooling, the heat transfer on the outside of the spinning engine is in the same range as the inside allowing for a substantial increase in inlet temperatures. ~~Computer modeling or simple rig tests can predict the exact heat transfer situation.~~

The external rotor gas turbine requires no scientific, technological, fabrication or other breakthroughs to design or to build. The radial flow turbine could be fabricated from parts machined on a lathe. An insert would be shaped to fit between the two outer disks, and then cut to produce the desired nozzles. Held in place with a jig, the assembly would be electron beam welded together. ~~The outside of the external rotor of the axial compressor embodiment could be machined in one piece, preferably from a light alloy or titanium, then spin balanced and mounted on the internal stator. Ringed inserts alternately containing rotor and stator stages could then be loaded into the compressor. Alternatively, the compressor rotor could be built in two halves like a conventional compressor~~

~~housing, and, attached with low profile radially symmetrical fittings after it is mounted onto the internal stator. The compressor could then be attached to a rotating combustor section or directly to the reaction turbine if the combustor was located in the radial flow or tip area of the engine.~~

In Fig. 4 the cascaded diffuser **104** of the stator of the centrifugal compressor could be fabricated in pie shaped parts and assembled on the stator inside of the carbon fiber element **106** before that element was attached to the rest of the compressor shell. If a design required film cooling, channels could route air from just downstream from the compressor to the nozzles, similar to film cooling in a ram jet.

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